Adult and Juvenile Coho Salmon Enumeration and Coded-wire Tag Recovery Analysis for Zolzap Creek, BC, 1997

B.L. Nass and H.R. Frith

Fisheries and Oceans Canada
Room 202, 417-2nd Ave.
Prince Rupert, BC
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ADULT AND JUVENILE COHO SALMON ENUMERATION AND CODED-WIRE TAG RECOVERY ANALYSIS FOR ZOLZAP CREEK, BC, 1997

prepared by

Bryan L. Nass and H. Russ Frith

LGL Limited
environmental research associates[1]

for the

Nisga'a Tribal Council[2]

[1] 9768 Second St., Sidney, BC V8L 3Y8

[2] P.O. Box 231, New Aiyansh, BC V0J 1A0

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ABSTRACT

Nass, B.L. and H.R. Frith. 2001. Adult and juvenile coho salmon enumeration and coded-wire tag recovery analysis for Zolzap Creek, BC, 1997. Can. Manuscr. Rep. Fish. Aquat. Sci. 2565: viii + 41 p.

Adult and juvenile coho migrations were monitored at Zolzap Creek, British Columbia, as part of the 1997-1998 Nisga'a Aboriginal Fisheries Strategy. The 1997 season is the sixth year of continuous operation of the Zolzap Creek fences. This report includes six year summaries of the most pertinent data. Smolt trapping was conducted from 23 April to 20 June using an instream wire-mesh fence. A total of 15,099 coho smolts were captured during the trapping period, and an unknown number migrated out during periods when the fence was not operational. Of those captured, 13,566 were released with coded-wire tags. Migration timing, mean length and weight at age, and age composition are presented.

Adult coho escapement was monitored using an instream fence and carcass surveys. The counting fence was operational between 7 September and 27 October. A total of 470 adult coho were counted at the fence. Adipose clip rate was the highest ever reported at 43.5% for Zolzap adult coho. Age and length characteristics of adult males and females are presented.

Canadian and US commercial harvests were examined using coded-wire tag recovery data obtained from the Mark-Recovery Program. Total commercial exploitation rate on Zolzap Creek coho in 1997 was 54.2% (8.8% Canadian, 45.4% US). Of the total commercial catch of Zolzap Creek coho, Canadian catch accounted for 16% and the US catch accounted for an estimated 84%. Harvests occurred over a wide area ranging from Canadian Statistical Area 1 (Dixon Entrance) to the Northern Outside Statistical Area in Alaska (northwest of Juneau, AK). Canadian harvests were restricted to Statistical Area 1 for troll fisheries (no net fishery). US harvests of Zolzap coho in Alaska were largest in the Southern Inside Statistical Area for the net fishery and the Central Outside Statistical Area for the troll fishery. Total survival was 2.4% and smolt-to-spawner survival was 1.1%.

RÉSUMÉ

Nass, B.L. and H.R. Frith. 2001. Adult and juvenile coho salmon enumeration and coded-wire tag recovery analysis for Zolzap Creek, BC, 1997. Can. Manuscr. Rep. Fish. Aquat. Sci. 2565: viii + 41 p.

Les migrations de saumons coho, adultes et jeunes, ont été mesurées au ruisseau Zolzap en Colombie-Britannique, dans le cadre de la Stratégie des pêcheries autochtones des Nisga'a en 1997-1998. L'année 1997 marque la 6ième saison d'opération continue des barrières en fil métallique du ruisseau Zolzap. Ce rapport contient 6 ans de sommaires des données les plus intéressantes. Le piégeage des saumoneaux prit place entre le 23 avril et le 20 juin à l'aide d'une barrière en fil métallique installée dans le ruisseau. En tout, 15,099 saumoneaux coho ont été capturés pendant la période de piégeage tandis qu'un nombre inconnu a migré quand la barrière n'était pas opérationelle. Sur l'ensemble des saumoneaux capturés, 13,566 ont été remis à l'eau avec une marque magnétique codée. La période de migration, la longueur moyenne, le poids et la composition selon l'âge sont présentées.

La remonte de saumons coho adultes a été surveillée grâce à une barrière installée dans le ruisseau et à l'observation des carcasses. La barrière de comptage fut opérationelle entre le 2 septembre et le 11 novembre. Un total de 470 saumons coho adultes ont été dénombrés à la barrière. Le taux d'ablation de la nageoire adipeuse était de 43.5% pour les saumons coho adultes du ruisseau Zolzap, un pourcentage plus élevé que jamais. Nous présentons les caractéristiques d'âge et de longueur pour les mâles et les femelles adultes.

Les récoltes commerciales canadiennes et américaines ont été examinées grâce aux données de récupération des marques magnétiques codées provenant du Programme de marquage-récupération. En 1997 le taux total d'exploitation commerciale de saumon coho au ruisseau Zolzap fut évalué à 54.2% (8.8% pour le Canada, 45.4% pour les États-Unis). Sur le total de prises commerciales de saumon coho au ruisseau Zolzap, le Canada en comptait 16% et les États-Unis 84%. Les récoltes couvraient un vaste secteur, s'étendant de la zone statistique canadienne 1 (entrée Dixon) à la zone statistique extérieure nordique en Alaska (au nord-ouest de Juneau, AK). Les récoltes canadiennes furent confinés à la zone statistique 1 pour la pêche à la traîne (pas de pêche au filet). Les saumons coho du Zolzap récoltés par les États-Unis en Alaska furent plus nombreux dans la zone statistique sud intérieure pour la pêche au filet, et, dans la zone statistique centrale extérieure pour la pêche à la traîne. Le taux total de survie fut 2.4% tandis que pour les saumoneaux/géniteurs le taux de survie fut 1.1%.

INTRODUCTION

As part of an agreement between the Nisga'a Tribal Council and the Canadian Government, an Interim Measures Program (IMP) was established for fisheries research in the Nisga'a Traditional Territory, British Columbia. One component of this large research initiative focussed on the assessment of juvenile and adult coho populations in tributaries to the Nass River. Juvenile and adult coho enumeration studies have been conducted on Zolzap Creek since 1992 (Nass 1996a; Nass 1996b; Nass and English 1994; Nass 1996c; Nass 1997a; Nass 1997b; Nass 1999). This report presents results for studies conducted at Zolzap Creek in 1997.

The objectives of the research were to:

1. Enumerate migrating juvenile coho and estimate escapement;

2. Document the timing, size, and age distribution of migrating coho;

3. Mark coho smolts with coded-wire tags (CWT) to enable the determination of oceanic harvest rates;

4. Monitor the escapement for marked (CWT) adult coho, and determine oceanic exploitation and survival rates; and

5. Collect water temperature and level data for future examination of the relationships between physical environmental factors and coho smolt migration timing, and between adult escapement and smolt production.

Achievement of these objectives involved the construction and operation of instream, semi-permanent, panel fences located approximately 0.5 km upstream of the mouth of Zolzap Creek.

STUDY STREAM

Zolzap Creek is a tributary to the Nass River, located in northwestern British Columbia (Fig. 1 and 2). Zolzap Creek flows for 6 km in a northwesterly direction between Nisga'a Lava Bed Memorial Park and the Kitimat Mountain Range to its confluence with the Nass River, 5 km downstream of Gitwinksihlkw. The main channel of the creek is regularly interrupted by beaver dams and log jams. The substrate is highly variable and ranges between silty particulate, to granite cobble, and coarse pumice. Major flow contributions come from Lava Creek (3 km in length) which flows from the lava beds and numerous small creeks that flow from the steep alpine. Intermittent flows of water from the Nass River and Vedder Creek are possible during flooding periods. The mouth of Zolzap Creek enters a side channel to the Nass River known as Zolzap Slough. The lower 0.5 km of Zolzap Creek regularly becomes inundated when water levels on the Nass River are high. Zolzap Creek supports many species of salmonids including coho (*Oncorhynchus kisutch*), pink (*O. gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), rainbow

(*O. mykiss*), cutthroat (*O. clarki*), and Dolly Varden (*Salvelinus malma*). Non-coho species include lampreys (family Petromyzontidae), sticklebacks (family Gasterosteidae), and sculpins (family Cottidae). Coho escapement was estimated to be 1,561 in 1992 (Nass 1996b); 1,048 in 1993 (Nass 1996c); 2,536 in 1994 (Nass 1997a); 908 in 1995 (Nass 1997b) and 1,039 in 1996 (Nass 1999).

JUVENILE COHO STUDIES

METHODS

Trapping Operations

An instream, semi-permanent enumeration fence was located 0.5 km upstream of the creek mouth for the capture of downstream migrating coho smolts. Fence design was based on Conlin and Tutty (1979) and minor modifications were required due to site characteristics and available materials. The fence was built in a W-pattern and spanned the entire creek bed. Three by eight foot panels constructed of 2"x 4"s and covered with 1/4" wire-mesh were laid on their long side in the creek bed to form the fence. Rebar (3/8" and ½") was used to anchor the panels to the stream bed. A second layer of panels was installed on top of the first row of panels to create a fence a total of six feet in height. Burlap sandbags and heavy duty plastic garden sheeting were used to seal the base of the panels. Two hinged panels were installed in each of the fence wings for release of excess water in the event of flooding. Plywood trap boxes with Vexar-screened windows (to allow water exchange) were anchored at each downstream apex and were connected to the fence with eight inch "Big O" tubing. Additional live boxes were used to hold fish after tagging and were designed with a small door to release the fish. Provisions for upstream migrating adults were made by constructing a simple trap consisting of a wire-mesh panel extending out from the stream bank to one wing of the fence. Plywood was used to cover the adult trap area.

Separate trapping operations were conducted during the late summer to assess the number of coho smolts outmigrating later in the season and to assess the size and age composition of juvenile coho rearing in the upper reaches of Zolzap Creek. A rotary trap was operated during two periods between the end of June and mid-October. Juveniles were captured using roe-baited gee traps in the upper reaches during late September.

Physical Observations

Crews monitored water temperatures, water levels, and weather, daily. An electronic data logger (Unidata America, Lake Oswego, OR) was used to record daily maximum and minimum water temperatures, and level. In addition, crews recorded temperature to the nearest degree (1°C) using a maximum-minimum thermometer and water level using staff gauges calibrated to the nearest centimetre (0.01 m). Water level gauges were located within 50 m of the trapping site (one upstream, one downstream of the fence). Precipitation was recorded on a scale of 0 to 5 with 0 representing no precipitation and 5 being heavy precipitation.

Fish Enumerations

Daily numbers of coho smolts captured at the fence were obtained from automatic counters on coded-wire tagging machines or by manual counts. The number of fence mortalities was added to the total count. Coho juveniles with standard lengths greater than or equal to 70 mm were identified as smolts. Coho smaller than 70 mm tended to be dark with distinct parr marks and lacked the silver colouration typical of smolts. Therefore, this group consisted of pre-smolts and fry. All coho pre-smolts and fry, and non-coho species were counted and released downstream of the fence during sorting. Upstream migrating juveniles caught in the adult traps were counted and released upstream.

Biosampling

A random sample of up to 25 smolts (i.e., coho greater than or equal to 70 mm) were obtained from each day's catch. These smolts were anaesthetized and measured for fork length and weighed using an electronic scale (0.1 g). Scale sampling followed the stratified method of Ketche, described by Ricker (1975): age sample data (column X on Table 1) included non-random samples and length sample data (column Y on Table 1). The calculated age representation was based on random sampling. Crews attempted to collect at least 10 scale samples from each 5 mm size class of coho for the study period. Smolts from under-represented size classes were selected to supplement random samples. Scale samples were interpreted by the Fisheries and Oceans Canada Scale Lab, Nanaimo, BC. Secondary quality control checks were performed to ensure a reliable age designation. Scale ages are reported in Gilbert-Rich notation where freshwater age 2 coho (i.e., having survived 2 winters from egg deposition) have a single freshwater annulus.

Biosampling was also conducted on a sub-sample of cutthroat and steelhead trout. Length, weight, scales and DNA tissue samples were obtained from adults and juveniles. No data or analysis is presented here, however, the data can be obtained from the principal author.

Coded-wire Tagging

Coded-wire tagging at Zolzap Creek was performed using a Mark IV tagging machine by (Northwest Marine Technology Ltd., Shaw Island, WA). Smolts were anaesthetized in a MS222 bath prior to tagging. All tagged fish were adipose fin-clipped (AFC). The numbers of coho smolts tagged with each tag code and the number of smolts untagged were recorded. All tagged smolts were placed in a holding box in the stream and allowed to recover from the tagging operation before release.

Tag retention tests were conducted for each tag code. A sample of tagged coho smolts (minimum of 200 smolts) was retained in a holding box for 24-h. Following the holding period, smolts were lightly anaesthetized and checked for the presence of a coded-wire tag using the quality control device (QCD) from the coded-wire tagging machine. Coho smolts not possessing

a tag were checked a second time. The total number of tags detected for each tag group and the total number of fish tested was recorded.

RESULTS

Physical Observations

Water temperatures during the smolt migration period at Zolzap Creek ranged from a minimum of 4° C, to a maximum of 9° C in mid-June (Fig. 3). Water level remained steady at a gauge height of 0.4 m from the beginning of monitoring on 23 April until 12 May. Water level rose sharply to 2.1 m within four days following 12 May and continued to fluctuate between 0.9 m and 2.1 m until the end of the spring monitoring period on 26 June. Water velocity decreased to a low rate and applied little pressure to the fence structure. Low velocity at high water levels is caused by the creek backing up when water levels of the Nass River are high.

Fish Enumerations

The Zolzap Creek juvenile counting fence was operated from 23 April to 20 June 1997. The water level reached the top of the fence, but did not top it. A fence panel blew out on 13 May, but a trawl net was installed to capture some of the passing fish. The panel was repaired on 19 May. The rotary trap was operated from 26 June to 3 August, and again from 17 September to 12 October with only minor interruptions in operation.

Trapping of summer juvenile coho using gee traps in upper Zolzap Creek was conducted on 24 September. All trapping occurred at the same location. A total of 541 fry and 439 pre-smolt coho were captured using 11 gee traps. Catch for individual traps ranged from 0 to 68 on soak times of 1½ - 2 hours. Recaptures accounted for less than 10% of the total catch.

Coho Smolts: A total of 15,099 coho smolts were counted at the fence (Table 2, Fig. 4). An additional 85 smolts were captured in the rotary trap from 17 September to 12 October. The rotary trap was also operated from 26 June to 23 July when 541 fry and 439 pre-smolt coho were captured. The maximum daily number of smolts captured at the fence was 928 and occurred on 27 May (Table A-1). An unknown number of smolts moved past the trapping location during temporary fence failures. An additional 3,000 smolts were estimated to have left the system based on the pattern of migration. There were a total of 1,127 fry and 878 pre-smolt coho counted and released during trapping operations (Table B-1).

Non-coho Species: Lampreys (larvae and young adults) were caught in the largest numbers followed by juvenile chum and Dolly Varden (Table 3, Table C-1).

Biosampling: Length, Weight, and Age

The mean fork length of age 2 smolts was 94.4 mm and the mean weight was 8.3 g (Table 1). Age 3 smolts averaged 105.3 mm and 11.6 g. The length-frequency distribution showed

substantial overlap between age 2 and age 3 coho (Fig. 5). Age 2 smolts were most numerous in the 96-100 mm length class, and age 3 smolts were most numerous in the 101-105 mm length class. Age 3 coho smolts were significantly larger than age 2 smolts (t-test, $p < 0.001$). Overall, coho smolts averaged 98.3 mm in length. The calculated freshwater age structure of coho smolts was 65.1% age 2 and 34.9% age 3. No age 4 were observed (Table 1).

Coded-wire Tagging

Mean tag retention was 100% for tag code 28-16-20 (Table 4). Crews conducted four tests for tag code 28-16-20 for a total of 765 samples and found no tag losses.

Releases of AFC coho totalled 13,566 (Table 5, Table A-1). Crews recorded 121 mortalities associated with the tagging process. The total number of coho smolts released with coded-wire tags was 13,566. Approximately 7% (992) of the captured coho smolts were released untagged during the study period. The total number of smolts released was 14,558.

ADULT COHO STUDIES

METHODS

Population Estimates

An aluminum conduit fence anchored to a crib-type sill was constructed at Zolzap Creek. All salmonids caught at the fence were counted and classified by sex. Sex was distinguished on the basis of length and body morphology. Previous studies at Zolzap Creek (Nass 1996b, 1996c, 1997a, 1997b) have shown an absence of jacks in the escapement; therefore, all males were classified as adults. "Jack panels" consisting of one inch wire mesh were used to prevent the passage of small coho through the fence and were used whenever water levels and debris permitted. Each coho was tagged on the operculum with a uniquely numbered Ketchum kurl-lock tag and measured for length. During handling, fish were examined for fin clips or tags that would be associated with coded-wire tagging or mark-recapture studies taking place on the Nass River. All captured fish were released upstream of the fence.

Adult coho abundance downstream of the fence was assessed later in the migration period due to the lack of fish movement past the fence. Delayed migration was the result of persistent low water conditions in Zolzap Creek. Seining and gillnetting was conducted approximately 1 km downstream of the fence in Zolzap Slough to determine relative coho abundance and examine fish for AFC's. Multiple net drift sets were conducted over a 1 km stretch of Zolzap Slough, and angling was conducted in lower Zolzap Creek. Coho were examined for sex and AFC's, and a uniquely numbered opercular tag was applied. All fish captured were released back into Zolzap Slough. In addition, live coho were captured and carcasses were recovered in surveys conducted upstream of the fence. Carcasses were also recovered on the fence.

Biosampling

All live coho captured at the fence were measured for postorbital-hypural length and examined for fin clips and sex. Adipose tissue was collected from sub-samples of adult coho for DNA analysis. DNA samples were sent to the Pacific Biological Station (T. Beacham, Fisheries and Oceans Canada, Nanaimo, BC) for analysis. Data recorded from coho captured at the fence were used to calculate sex ratios and mean length by sex. Crews attempted to sample at least 25 coho per day for scales (10 scales per fish). Scale samples were sent to the Fisheries and Oceans Canada Scale Lab, Nanaimo, BC, for age determination. Secondary quality control checks were performed at the scale lab to ensure reliability of the age designations. Scale ages are reported in Gilbert-Rich notation where freshwater age 2 coho (i.e., having survived two winters from egg deposition) have a single freshwater annulus.

Adult returns (calculated by escapement method) and smolt production by CWT, and total populations were calculated for each brood year where data were available. Smolt output and adult escapement was apportioned between brood years (back-calculated) using the age structure observed in the respective yearly migrations. The sum of freshwater age 2, age 3, and age 4 individuals equals total production for a given brood year. Age composition for smolts and adults by brood year was calculated based on the estimated production. Total survival by brood year was calculated as the age-specific adult return divided by the respective smolt production. The smolt-to-spawner ratio for each brood year was calculated as the number of smolts produced divided by the number of adults in the escapement by brood year. Similarly, the recruit-to-spawner ratio for each brood year was calculated as the number of adults produced divided by the number of adults in the escapement by brood year.

Coded-wire Tag Recoveries

Coded-wire-tagged smolts were AFC prior to release. Coho smolts at Zolzap Creek were coded-wire-tagged (CWT) in the spring of 1996 (Nass 1999) during out-migration.

Escapement: Crews examined all coho captured at the fence for the presence or absence of the adipose fin. The contribution and survival of AFC coho to the escapement was determined using methods presented in Bocking et al. (1992) and modified in Nass (1997a). CWT heads were collected from fish sacrificed at the fence, the native net and angling fisheries, and from carcass recoveries.

Commercial and Sport Harvests: Commercial and sport catches of CWT fish are monitored by Fisheries and Oceans Canada and various US agencies, and are compiled in the Mark Recovery Program (MRP). Data on CWT releases and recaptures are used to estimate the number of fish from a particular stock that have been harvested in the commercial and sport fishery, as well as determining the spatial and temporal distribution of harvests (Kuhn et al. 1988, Nass 1997a). The estimates include catch (observed catch corrected for sampling effort), expanded catch (estimated catch corrected for unmarked fish), exploitation rate (proportion of CWT coho caught in the fishery), and total return (expanded catch plus escapement).

Geographic Distribution of Harvest: Coded-wire-tagged fish in the commercial catch are recorded by Canadian and US fishery Statistical Areas. To estimate number of recoveries for each Canadian area, the observed CWT catch was expanded by the mean catch-sampling ratio observed in the Catch Region (e.g., Northern Troll = Statistical Areas 1, 3, 4, and 6). Similarly, US troll catch was expanded using the catch sampling ratio by quadrant (e.g., northwest) and the net catch sampling ratios, by district.

RESULTS

Physical Observations

During the period that the adult fence was operational, water temperatures ranged from a maximum of 9°C in early September to a minimum of 1°C in mid-November (Fig. 3). Water level ranged from 0.4 m during base flows to 0.6 m during freshets (Fig. 3).

Adult Enumerations

The fence was operated continuously from 2 September to 11 November. A total of 470 adult coho salmon were counted at the fence (Table 6). Of these, 445 adults were operculum tagged and released upstream. Maximum daily migration past the fence was 159 adults on 17 October (Table D-1, Fig. 6).

Coho population assessments below the fence were conducted on 10, 13, 20, and 28 October; and 6 November. A total of 56 coho were captured using nets and angling. All coho were sexed, opercular tagged and checked for AFC's. Twenty-six coho were captured using nets and 30 were captured by angling. Of the 56 tagged coho released below the fence, five (8.9%) were recaptured below the fence during the surveys, and 18 (32%) were observed at the fence. Therefore, at least 38 coho remained below the fence.

Thirteen surveys were conducted upstream of the fence at four access locations along the creek during the period 20 October to 17 December. Upstream surveys were conducted on 2 November in areas within 1 km above the fence; 20 and 28 October, and 1 and 17 December at Goat Creek (a tributary); 30 October, 3, 13, 17, 21, and 28 November; and 4, 13, and 17 December at upper Zolzap Creek. A total of 38 adult coho (27 live, 11 dead) were examined during upstream surveys and on the fence (Table 6). All but one coho had been tagged at the fence; therefore, no mark-recapture estimate was calculated.

For non-coho species captured at the fence, pinks had the greatest abundance (44), followed by chum (42), and sockeye (39). Dolly Varden (21), cutthroat (12) and lamprey (4) were also captured at the fence (Table 3). No steelhead were observed in 1997. Chum and pink were caught in their greatest numbers in early September and sockeye were caught mainly in late September. Cuthroat and Dolly Varden were mainly caught in mid-October. No population estimates were derived for non-coho species.

Biosampling: Age and Length

A total of 328 coho were sampled for scales, of which 271 were successfully aged (Table 7). Unaged samples included marine regenerates. Adult males and females had different age compositions which averaged 79.6% and 53.3% freshwater age 2, and 20.4% and 46.7% freshwater age 3, respectively. The total age composition was 70.8% age 2, and 29.2% age 3. All aged scales were recorded as marine age 1 (i.e., having one marine annulus).

Mean lengths of adult males and females were 46.2 cm (n=300, SD=9.57) and 53.2 cm (n=164, SD=6.00), respectively. Adult male coho were widely distributed over the range of 27-69 cm with a mode of 40 cm (Fig. 7). Female coho had a mode of 50 cm with a range of 39-73 cm. For coho sexed during processing, adult males captured at the fence (n=300) were more abundant than females (n=164). A total of 201 adipose tissue samples were collected at Zolzap Creek.

Coded-wire Tag Recoveries

Escapement: Crews examined 462 adult coho at the fence for fin clips of which 201 were AFC (43.5%, Table 8). An estimated 204 AFC adult coho returned to Zolzap Creek in 1997. In addition, of the 56 coho examined below the fence, 28 (50%) were AFC. Of the 28 AFC coho tagged below the fence, 8 were observed at the fence. Therefore, at least 20 AFC coho remained below the fence. Smolt to spawner survival (i.e., includes natural and harvest mortality) for adult coho was estimated at 1.1%.

Twenty-five (25) CWT heads were collected at Zolzap Creek. Of these recoveries, 18 were from sacrifices at the fence and 7 were from carcass recoveries. All the CWT recoveries at Zolzap Creek were from the 1996 release at Zolzap Creek (code 18-20-52 and 18-20-53).

Commercial and Sport Harvests: Total observed Zolzap Creek coho CWT recoveries were 8 and 77 for Canadian and US (Alaska) fisheries, respectively (Table 9). Estimated sport CWT recoveries totalled 12 for Canadian fisheries and was the highest observed since 1993. All CWT recoveries were from the 1996 release year. Northern Canadian troll catch-to-sample ratio was 8.3, while US troll and net ratios were 5.5 and 5.3, respectively (Table 9). Estimated Zolzap Creek CWT coho catches were 43 and 219 for Canadian and US fisheries, respectively (Table 9).

Expanded Canadian and US catches were 46 and 239, respectively, for a total of 285 using the CWT mark ratio at release (i.e., MRP method) (Table 10). Expanded Canadian and US catches were 99 and 510, respectively, for a total of 608 using the adipose-clip ratio at recovery (i.e., escapement method). Estimated total adult return for Zolzap Creek coho was 491 and 1,078 using the MRP and escapement methods, respectively (Table 10).

Of the total commercial catch of Zolzap Creek coho, Canadian fisheries accounted for 12% and the US accounted for 88% (Table 11). Troll fisheries accounted for 100% of the total Canadian catch. No net fishery was operated during the coho run to conserve stocks. US troll and net fisheries accounted for 87.4% and 12.6% of the total US catch, respectively. Commercial

harvest of Zolzap Creek coho occurred over a wide area ranging from Canadian Statistical Area 1 to the US Northern Outside Statistical Area in Alaska (Fig. 8). Canadian harvests were restricted to Statistical Area 1 for the troll fisheries (no commercial net fishery) (12.3%, Table 11). US harvests were largest in the Southern Inside Statistical Area for the net fishery (6.8%) and the Central Outside Statistical Area for the troll fishery (50.8%).

Total commercial exploitation rate (Canadian and US combined) on Zolzap Creek coho in 1997 was 54.2% (Table 12). Total Canadian exploitation rate was 8.8% (troll+sport) and total US exploitation rate was 45.4% (39.2% troll, 6.2% net). Total survival based on CWT returns was 2.4% (Table 12).

DISCUSSION

Over the past 6 years of monitoring, the average number of smolts estimated leaving Zolzap Creek was 33,167 (Table 12). For the same time period, the average age composition of the smolt population was 57.4% age 2, 41.2% age 3, and 1.4% age 4.

Adult coho counted at the fence in 1997 totalled 470 (Table 6). After CWT sacrifices (n=17), escapement was 453 plus an undetermined number of coho that spawned below the fence. The native and sport fisheries harvested an unknown number of coho below the fence, therefore, our estimate of actual survival may be higher than reported. Average escapement for 1992-1997 was 1,260 (Table 12).

Data from 1992-1996 have indicated that there are no jacks in the Zolzap Creek escapement (Nass 1996b, 1996c, 1997a, 1997b, 1999). In 1997, CWT and scale ageing data have again confirmed the absence of jacks in the population. There were 25 heads taken for CWT sampling from adipose clipped coho. Fish with CWT's measured between 28 and 59 cm (post-orbital-hypural) and were found to all be from 1996 releases. Thirteen of the samples were from coho measuring less than 35 cm. This length has been used in previous studies at other British Columbia streams to designate jacks in the escapement and is based on CWT analysis. Both the CWT analysis and scale ageing show that coho less than 35 cm from Zolzap Creek in 1997 were marine age 1.

In Alaska, comprehensive information exists for several southeast stocks, including Hugh Smith Lake (Southern Inside Statistical Area, see Fig. 8), which has been monitored since 1982. Preliminary data for the 1997 return suggests exploitation rates of 3.4% Canadian and 69.0% US (72.4% total; Leon Shaul, Alaska Dept. of Fish and Game, Douglas, AK, pers. comm.). Southeast Alaska and Canadian fisheries accounted for approximately 95.4% and 4.6% of the commercial catch of Hugh Smith coho, respectively. The total exploitation rate on Hugh Smith coho at 72.4% was substantially higher than exploitation rates of 8.8% Canadian and 45.4% US (54.2% total) on Zolzap Creek coho in 1997. Preliminary CWT data for the 1997 return of Hugh Smith coho suggest a survival rate of 8.2% which is higher than for Zolzap Creek coho at 2.4%. Hugh Smith coho have in previous years had substantially higher survivals (1996: 17.9%, 1995: 13.7%,

1994: 19.4%, 1993: 13%) compared to Zolzap coho (1996: 6.6%, 1995: 3.6%, 1994: 8.9%, 1993: 2.1%) in the previous four years.

Zolzap Creek CWT coho have been subjected to total exploitation rates between 54.2% and 72.3%, and have had total survival rates between 2.1% and 8.9% over the period 1993 to 1997 (Table 12). Exploitation rates of Zolzap coho have ranged from 8.8% to 21.4% for the Canadian fishery and from 39.2% to 54.8% for the US fishery. Of the total commercial and sport catch of Zolzap Creek coho, the Canadian fishery has averaged 24.2% and the US fishery has averaged 75.8% over the same time period (Table 12).

Total smolt production by brood year averaged 35,043 (1990-1993) and was composed primarily of freshwater age 2 fish (62.8%, Table 13). Total adult production by brood year averaged 4,456 (1990-1993) and was 59.2% age 2 fish. Age composition at return was substantially different from that observed in the respective smolts populations and varied widely. Freshwater age 4 fish were absent from all adult escapements. Total survival by brood year of all Zolzap coho (unmarked + CWT) averaged 13.7% (1990-1993, Table 13). Total survival of Zolzap CWT coho was substantially lower at 5%. Higher survival for all coho compared to CWT coho is likely due to a significant number of unmarked smolts leaving Zolzap during non-operational periods (Nass 1996c). The effects of these conditions are evident from the historical data which shows the AFC rate at release has been roughly three times that of the AFC rate at return for the period 1993-1997 at Zolzap Creek (Table 8). Therefore, by using only CWT fish, the uncertainty around the number of fish released is eliminated and produces a more accurate estimate of survival.

Total survival of CWT coho by age class and brood year showed that smolts of the same marine year had consistent magnitude and trend in the rate of survival (Table 13). For example, age 3 smolts from the 1990 brood had a total survival of 11% while age 2 smolts from the 1991 brood were 8%. Survival then decreases in the next marine year when age 3 smolts from the 1991 brood (3.1%) migrated with age 2 smolts of the 1992 brood (5.1%). These patterns continue through the 1994 brood for which data is available.

The number of smolts per spawner was 11.1 and 12.8 for the brood years 1992 and 1993, respectively. These values are conservative as the number of smolts released are likely underestimated. The number of recruits per spawner was 1.8 and 1.9 for the 1992 and 1993 brood years, respectively.

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REFERENCES

Bocking, R.C., R.E. Bailey, and J.R. Irvine. 1992. Coho salmon (*Oncorhynchus kisutch*) escapement studies in Black Creek, French Creek, and Trent River, Vancouver Island, 1989. Can. Manuscr. Rep. Fish. Aquat. Sci. 2160: 77 p.

Conlin, K. and B.D. Tutty. 1979. Juvenile salmonid field trapping manual. Fish. Mar. Serv. Manuscr. Rep. 1530: 136 p.

Kuhn, B.R., L. Lapi, and J.M. Hamer. 1988. An introduction to the Canadian database on marked Pacific salmonids. Can. Tech. Rep. Fish. Aquat. Sci. 1649: viii + 56 p.

Nass, B.L. 2001. Adult and Juvenile coho salmon enumeration and coded-wire tag recovery analysis for Zolzap Creek, BC, 1996. Can. Manuscr. Rep. Fish. Aquat. Sci. 2564: + 44 p.

Nass, B.L. 1997a. Adult and Juvenile coho salmon enumeration and coded-wire tag recovery analysis for Zolzap Creek, BC, 1994. Can. Manuscr. Rep. Fish. Aquat. Sci. 2420: viii + 54 p.

Nass, B.L. 1997b. Adult and Juvenile coho salmon enumeration and coded-wire tag recovery analysis for Zolzap Creek, BC, 1995. Can. Manuscr. Rep. Fish. Aquat. Sci. 2423: viii + 54 p.

Nass, B.L. 1996a. Enumeration and coded-wire tagging of coho salmon smolts at Zolzap Creek, and enumeration of coho salmon smolts at Seaskinnish and Ginlulak Creeks, 1992. Can. Manuscr. Rep. Fish. Aquat. Sci. 2376: viii + 44 p.

Nass, B.L. 1996b. Escapement enumeration studies of adult coho salmon at Zolzap Creek, BC, 1992. Can. Manuscr. Rep. Fish. Aquat. Sci. 2374: viii + 30 p.

Nass, B.L. 1996c. Escapement enumeration studies of adult coho salmon at Zolzap Creek, BC, 1993. Can. Manuscr. Rep. Fish. Aquat. Sci. 2373: viii. + 35 p.

Nass, B.L. and K.K. English. 1994. Enumeration and coded-wire tagging of coho salmon smolts at Zolzap Creek, 1993. Report NF 93-01 prepared by LGL Limited, Sidney, BC, for Nisga'a Tribal Council, New Aiyansh, BC.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Bd. Can. 191. 382 p.

TABLES

Table 1. Age -length distribution of Zolzap Creek coho smolts, 1997.

Size-Class (mm)	Age Sample (X)	Age-groups in X 2	3	Length Sample (Y)	Calculated Age Representation in Y 2	3
70	8	8	0	8	8.0	0.0
75	24	24	0	26	26.0	0.0
80	21	21	0	22	22.0	0.0
85	44	43	1	47	45.9	1.1
90	98	92	6	106	99.5	6.5
95	164	139	25	185	156.8	28.2
100	226	153	73	257	174.0	83.0
105	152	78	74	196	100.6	95.4
110	108	36	72	130	43.3	86.7
115	50	11	39	63	13.9	49.1
120	18	6	12	26	8.7	17.3
125	15	0	15	19	0.0	19.0
130	7	0	7	9	0.0	9.0
135	1	0	1	1	0.0	1.0
140	3	0	3	3	0.0	3.0
145	0	0	0	1	0.0	1.0
150	0	0	0	0	0.0	0.0
155	0	0	0	0	0.0	0.0
160	0	0	0	0	0.0	0.0
165	0	0	0	0	0.0	0.0
170	0	0	0	0	0.0	0.0
175	0	0	0	0	0.0	0.0
180	0	0	0	0	0.0	0.0
185	0	0	0	0	0.0	0.0
Mean length	98.3	94.4	105.3	98.9		
SD	11.44	9.39	11.55	11.36		
Mean weight (g)	9.46	8.34	11.52	9.63		
SD	3.061	2.392	3.090	3.093		
Total samples	939	611	328	1099	715	384
% contribution		65.1	34.9		65.1	34.9

Table 2. Coho smolt catch at Zolzap Creek enumeration fence, by week, in 1997.

Week ending	Catch
26-Apr	104
3-May	511
10-May	1,933
17-May	2,211
24-May	1,961
31-May	4,621
7-Jun	2,263
14-Jun	1,280
21-Jun	215
Total	15,099

Table 3. Non-coho catch at the spring juvenile and fall adult fences at Zolzap Creek, 1992-1997[a].

Species	Time/lifestage	1992	1993	1994	1995	1996	1997	Avg.
Pink	Fall Adult	115	149	251	52	72	44	114
Chum	Spring Juvenile						344	344
	Fall Adult	30	111	68	8	19	42	46
Sockeye	Spring Juvenil	4	244	328	189	119	0	147
	Fall Adult	4	11	28	7	0	39	15
Cutthroat	Spring Juvenil	12	69	36	67	121	42	58
	Spring Adult	308	278	224	43	55	2	152
	Fall Adult	17	27	14	28	18	12	19
Dolly Varden	Spring Juvenil	682	309	339	518	711	337	483
	Spring Adult	644	728	1529	28	44	7	497
	Fall Adult	9	21	10	81	39	21	30
Steelhead	Spring Juvenil	11	15	36	12	30	4	18
	Spring Adult	33	0	5	0	0	0	6
	Fall Adult	5	0	2	0	0	0	1
Lamprey[b]	Spring Juvenil	749	906	1277	2314	1333	1794	1396
	Spring Adult	-	-	-	-	28	97	63
	Fall Adult	-	-	-	2	16	4	7

[a] Trapping effort not equal between years.

[b] Adults and juveniles not distingushed for period 1992 - 1995.

Table 4. Coded-wire tag retention rates for Zolzap Creek coho smolts, 1997.

Sampling date	Tagging date	Tag code	Hours held	Sample size	No. tags lost	Percent retention
21-May	20-May	16-20-28	24	200	0	100
23-May	21-May	16-20-28	48	191	0	100
12-Jun	09-Jun	16-20-28	72	174	0	100
16-Jun	12-Jun	16-20-28	96	200	0	100
Total				765	0	100

Table 5. Coded-wire tagged coho smolt releases from Zolzap Creek, 1997.

Tag code	Tagging dates	No. AFC	Tag morts	No. released AFC	No. tagged [a]	No. AFC only [b]	No. released untagged [c]	Total release [d]	CWT mark rate [e]
16-20-28	8 May - 16 June	13,687	121	13,566	13,566	0	992	14,558	1.07

[a] No. tagged (corrected for tag loss) = No. released AFC - (No. released AFC * No. lost tags / No. sampled); see Table 4.

[b] No. AFC only = No. released AFC - No. tagged

[c] No. released untagged = the number of unmarked fish released which belong to the same group as the tagged and AFC only fish.

[d] Total release = No. tagged + AFC only + untagged

[e] CWT mark rate = Total release / No. tagged

Table 6. Adult coho enumerations and carcass recoveries at Zolzap Creek fence, 1997.

Item	No. of adults
Number live coho captured at fence	470
Number of live coho released untagged	7
Number of coho sacrificed at the fence	17
Number live coho operculum tagged	445
Number coho recovered (live+dead)	38
Number of coho recovered untagged (live+dead)	1
Number of coho recovered with lost tags (live+dead)	1

Table 7. Freshwater age distribution of adult coho at Zolzap Creek, 1997.

Sex	Age 2		Age 3		Total aged	Total unaged	Total sampled
	No.	%	No.	%			
Adult males	144	79.6	37	20.4	181	34	215
Adult females	48	53.3	42	46.7	90	23	113
Adult (sex unknown)	0	0.0	0	0.0	0	1	1
Total adults	192	70.8	79	29.2	271	58	328

Table 8. Estimates of total escapement of adipose clipped coho and contribution to escapement at Zolzap Creek, 1993-1997.

Year	No. examined (A)	No. with adipose clips (B)	% AFC (C=B/Ax100)	Population estimate (D)	% sampled (E=A/Dx100)	Estimated adipose clips (F=B/AxD)	No. smolts[a] AFC	unclipped	% AFC	Contribution to escap.[b]	Smolt to spawner (%)[c]
1993	784	191	24.4	1,048	74.8	255	33,923	6,678	83.6	306	0.8
1994	2,416	499	20.7	2,536	95.3	524	22,986	3,348	87.3	600	2.3
1995	906	308	34.0	908	99.8	309	29,615	4,804	86.0	359	1.0
1996	1,030	218	21.2	1,039	99.1	220	10,166	2,203	82.2	268	2.2
1997	462	201	43.5	470	98.3	204	20,625	1,265	94.2	217	1.1
Avg.	1,120	283	28.7	1,200	93.5	302	23,463	3,660	86.7	350	1.5

[a] smolt releases of the previous migration year; an unknown number of additional unclipped releases were likely.

[b] marked contribution to escapement = estimated adipose clips * (clipped + unclipped) / clipped

[c] % survival = estimated AFC + AFC below the fence / AFC smolts * 100

Table 9. Estimated Canadian and American commercial and sport harvest of Zolzap Creek CWT coho in 1997 using tag recovery data (Mark Recovery Program, Fisheries and Oceans, Canada).

Tag code	Observed CWT catch [a]				Catch-sample ratio [b]			Estimated CWT catch [c]			
	N. Troll	N. Net	Sport	Total	N. Troll	N. Net	Sport	N. Troll	N. Net	Sport	Total
Canadian											
18-20-52	5	0	1	6	4.8	0.0	12.0	24	0	12	36
18-20-53	2	0	0	2	3.5	0.0	0.0	7	0	0	7
Total	7	0	1	8	8.3	0.0	12.0	31	0	12	43
American											
18-20-52	51	7	0	58	3.1	2.2	0.0	158	15	0	173
18-20-53	15	4	0	19	2.4	3.1	0.0	36	12	0	49
Total	66	11	0	77	5.5	5.3	0.0	194	28	0	222
Total	73	11	1	85	13.8	5.3	12.0	225	28	12	265
								Total commercial			253
								Total sport			12
								Total native fishery [d]			0
								Total escapement [e]			224
								Total CWT			489

[a] Observed CWT = CWT's recovered from the commercial and sport catch

[b] Cumulative catch-sample ratio = total coho catch / total coho sampled

[c] Estimated CWT = observed CWT catch * catch sampling ratio

[d] observed harvest

[e] Estimated CWT's (adipose clips corrected for tag loss at return) including those below the fence; see Table 8

Table 10. Expanded Canadian and American commercial and sport harvest of Zolzap Creek coho and estimated total return, 1997.

Tag code	Total release	Smolts tagged [a]	Mark rate [b]	Expanded catch [c]									Contribution escap.	Total return [d]
				Canadian				American				Grand Total		
				Troll	Net	Sport	Total	Troll	Net	Sport	Total			
18-20-52	11,467	10,540	1.09	26	0	13	39	172	17	0	188	227		
18-20-53	10,423	9,979	1.04	7	0	0	7	38	13	0	51	58		
Total 1 [e]	21,890	20,519	1.07	33	0	13	46	209	29	0	239	285	206	491
Total 2 [f]			2.30	71	0	28	99	446	63	0	510	608	470	1,078

[a] Number smolts released with tags (corrected for tag loss), Nass (1998).

[b] Mark rate at release (= No. released / No. marked) for smolts and Total 1 (MRP method), and mark rate at return for Total 2 (Escapement method).

[c] Expanded catch = EST * mark rate at release

[d] Total return = expanded catch + escapement

[e] Total 1 expanded catch is calculated using the total mark rate at release and the total estimated catch for all tag codes (Table 9).

[f] Total 2 expanded catch is calculated using the total adipose clip rate at recovery and the total estimated catch for all tag codes (Table 9).

Table 11. Estimated commercial harvest distribution of Zolzap Creek CWT coho by area and gear type, 1997. Percentage is of total commercial harvest (does not include sport recoveries).

Area [a]	Net	%	Troll	%	Total	%
Canada						
1	0	0.0	31	12.3	31	12.3
subtotal	0	0.0	31	12.3	31	12.3
U.S.A. (Alaska)						
Northern Outside	0	0.0	7	2.9	7	2.9
Central Outside	0	0.0	128	50.8	128	50.8
Southern Outside	7	2.9	8	3.0	15	5.9
Southern Inside	17	6.8	25	10.0	42	16.8
Central Inside	3	1.2	0	0.0	3	1.2
Southern Intermediate	0	0.0	19	7.5	19	7.5
Central Intermediate	0	0.0	7	2.6	7	2.6
subtotal	28	10.9	194	76.8	222	87.7
TOTAL	28	10.9	225	89.1	253	100.0

[a] includes respective sub-areas

Table 12. Adult and juvenile coho enumeration and age composition, and exploitation and survival at Zolzap Creek, 1992-1998.

Migration	Smolt Out-migration						Adult Escapement					Can		US		Total	
Year	Count	Estimate	CWT	% Age2	% Age3	% Age4	Count	stimate	Return	% Age2	% Age3	%Exp.	% Cat.	%Exp.	% Cat.	%Exp.	%Surv.
1992	40,601	53,000	33,150	54.3	45.7	0.0	691	1,561	-	79.0	21.0	-	-	-	-	-	-
1993	26,334	51,000	22,649	67.9	32.1	0.0	794	1,048	2,832	58.3	41.7	15.5	24.6	47.5	75.4	63.0	2.1
1994	34,419	41,000	29,319	29.8	69.5	0.7	2,438	2,536	9,645	60.4	39.6	18.6	25.7	53.7	74.3	72.3	8.9
1995	12,369	13,000	10,156	55.1	37.9	7.0	908	908	3,057	41.3	58.7	12.9	19.0	54.8	81.0	67.7	3.6
1996	20,745	23,000	20,519	72.2	27.1	0.7	1,039	1,039	3,159	53.2	46.8	21.4	35.3	39.2	64.7	60.5	6.6
1997	15,099	18,000	13,566	65.1	34.9	0.0	470	470	1,072	70.8	29.2	8.8	16.2	45.4	83.8	54.2	2.4
Average	24,928	33,167	21,560	57.4	41.2	1.4	1,057	1,260	3,953	60.5	39.5	15.4	24.2	48.1	75.8	63.5	4.7

Table 13. Adult and juvenile coho production and age composition by brood year, Zolzap Creek, 1990-1994[a].

CWT's

Brood Year	Smolt Production				Adult Returns			Smolts			Adults		% Total Survival			
	Age 2	Age 3	Age 4	Total	Age 2	Age 3	Total	% Age 2	%Age 3	%Age 4	% Age 2	%Age 3	Age 2	Age 3	Age 4	Total
1990	18,000	7,270	205	25,476	402	802	1,204	70.7	28.5	0.8	33.4	66.6	2.2	11.0	0.0	4.7
1991	15,379	20,377	711	36,466	1,223	628	1,851	42.2	55.9	1.9	66.1	33.9	8.0	3.1	0.0	5.1
1992	8,737	3,849	144	12,730	441	315	757	68.6	30.2	1.1	58.3	41.7	5.1	8.2	0.0	5.9
1993	5,596	5,561	0	11,157	359	136	495	50.2	49.8	0.0	72.5	27.5	6.4	2.4	-	4.4
1994	14,815	4,735	-	19,549	330	-	330	75.8	24.2	-	-	-	2.2	-	-	1.7
Avg.[b]	12,505	8,358	265	21,457	551	470	1,077	61.5	37.7	1.0	57.6	42.4	5.4	6.2	0.0	5.0

All fish

Brood Year	Smolt Production				Adult Returns			Smolts			Adults		% Total Survival			
	Age 2	Age 3	Age 4	Total	Age 2	Age 3	Total	% Age 2	%Age 3	%Age 4	% Age 2	%Age 3	Age 2	Age 3	Age 4	Total
1990	28,779	16,371	287	45,437	1,651	3,819	5,470	63.3	36.0	0.6	30.2	69.8	5.7	23.3	0.0	12.0
1991	34,629	28,495	910	64,034	5,826	1,794	7,620	54.1	44.5	1.4	76.5	23.5	16.8	6.3	0.0	11.9
1992	12,218	4,927	161	17,306	1,263	1,478	2,741	70.6	28.5	0.9	46.1	53.9	10.3	30.0	0.0	15.8
1993	7,163	6,233	0	13,396	1,681	313	1,994	53.5	46.5	0.0	84.3	15.7	23.5	5.0	-	14.9
1994	16,606	6,282	-	22,888	759	-	759	72.6	27.4	-	-	-	4.6	-	-	3.3
Avg.[b]	19,879	12,462	340	35,043	2,605	1,851	4,456	62.8	36.6	0.7	59.2	40.8	14.1	16.2		13.7

[a] (-) Incomplete data for 1994, to be completed with data from subsequent returns.

[b] average for "Total" includes years for which complete production data is available.

FIGURES

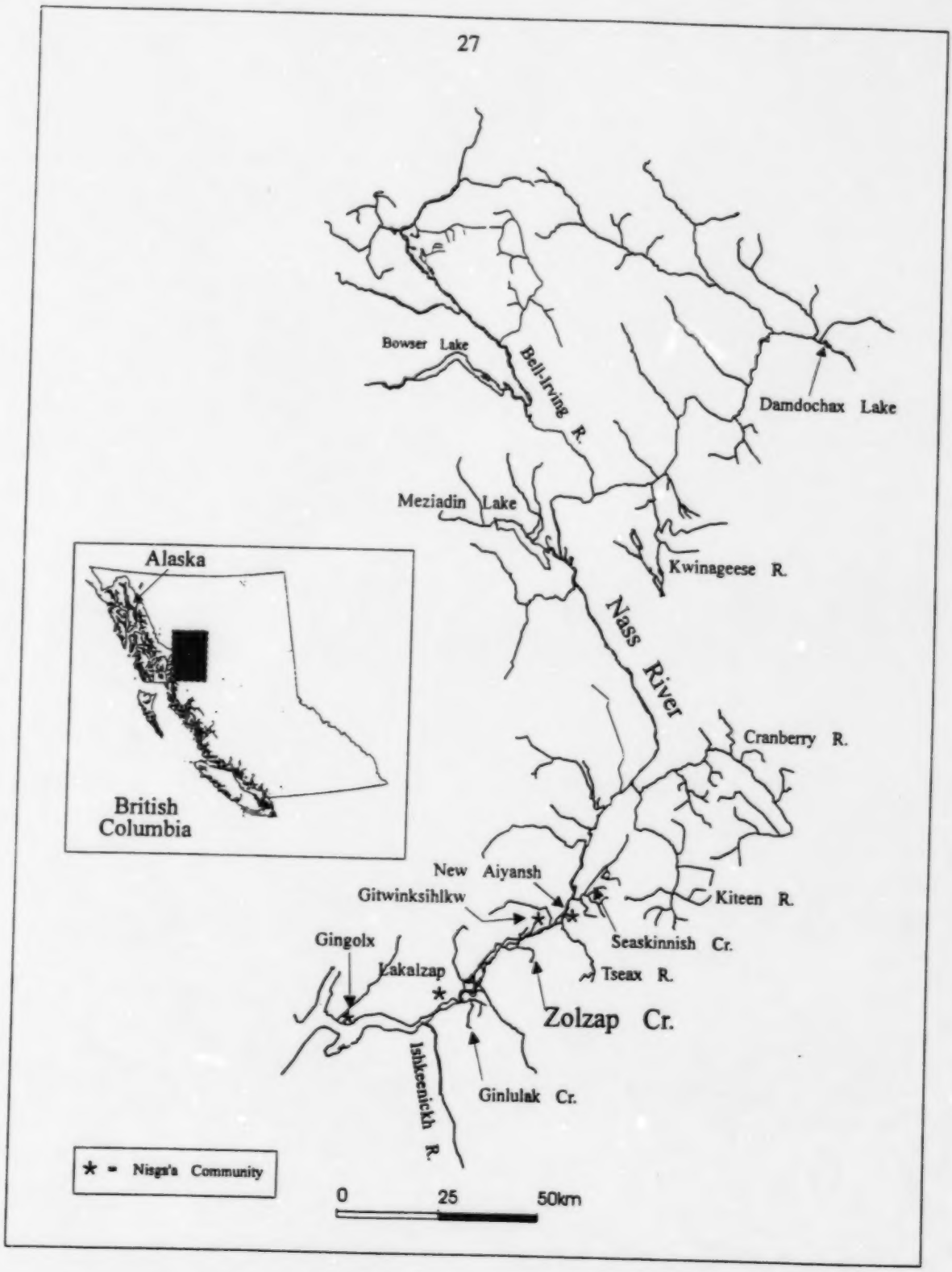

Figure 1. The Nass River watershed, British Columbia.

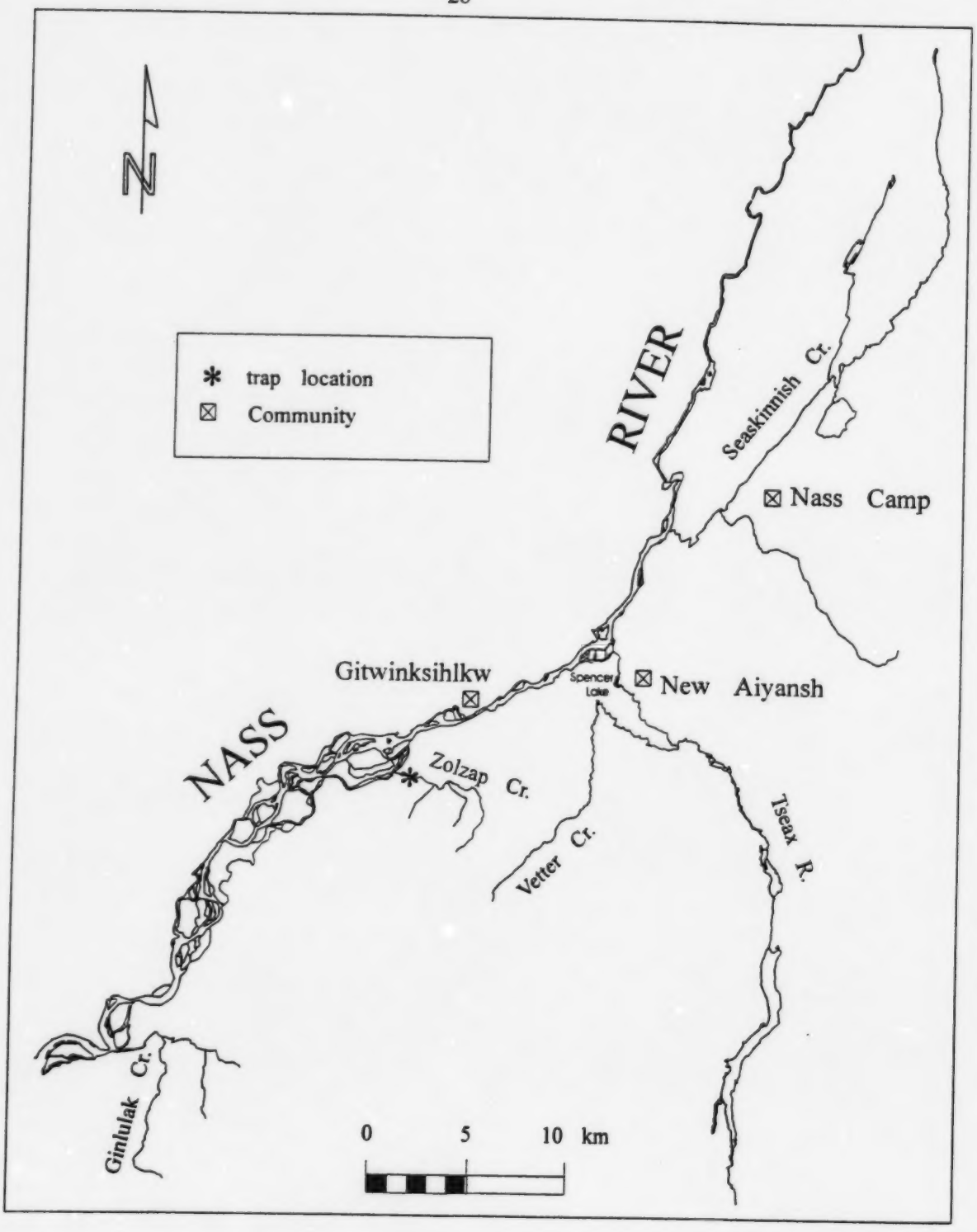

Figure 2. Zolzap Creek and location of enumeration fence.

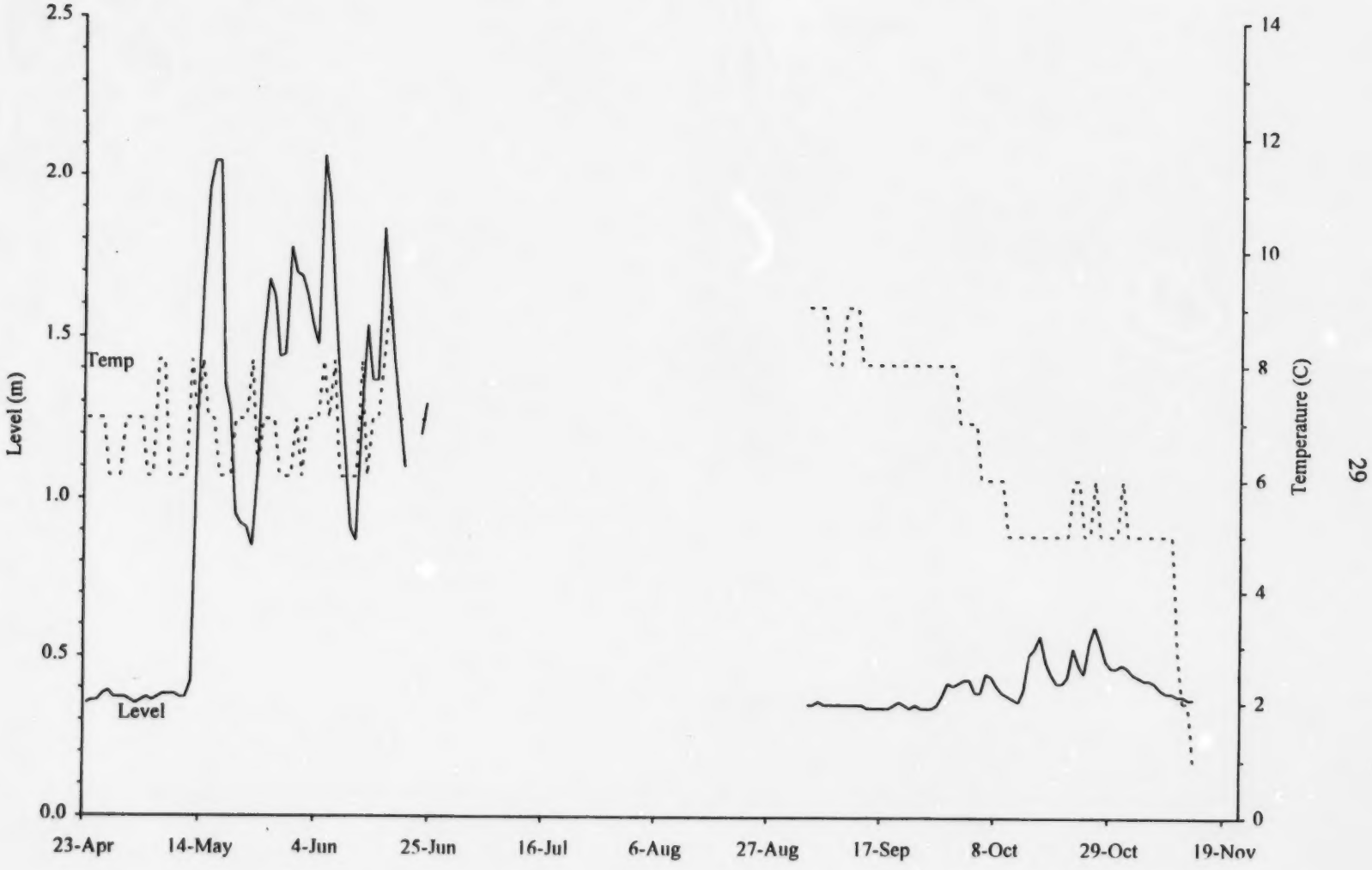

Figure 3. Water level and temperature at Zolzap Creek, 1997.

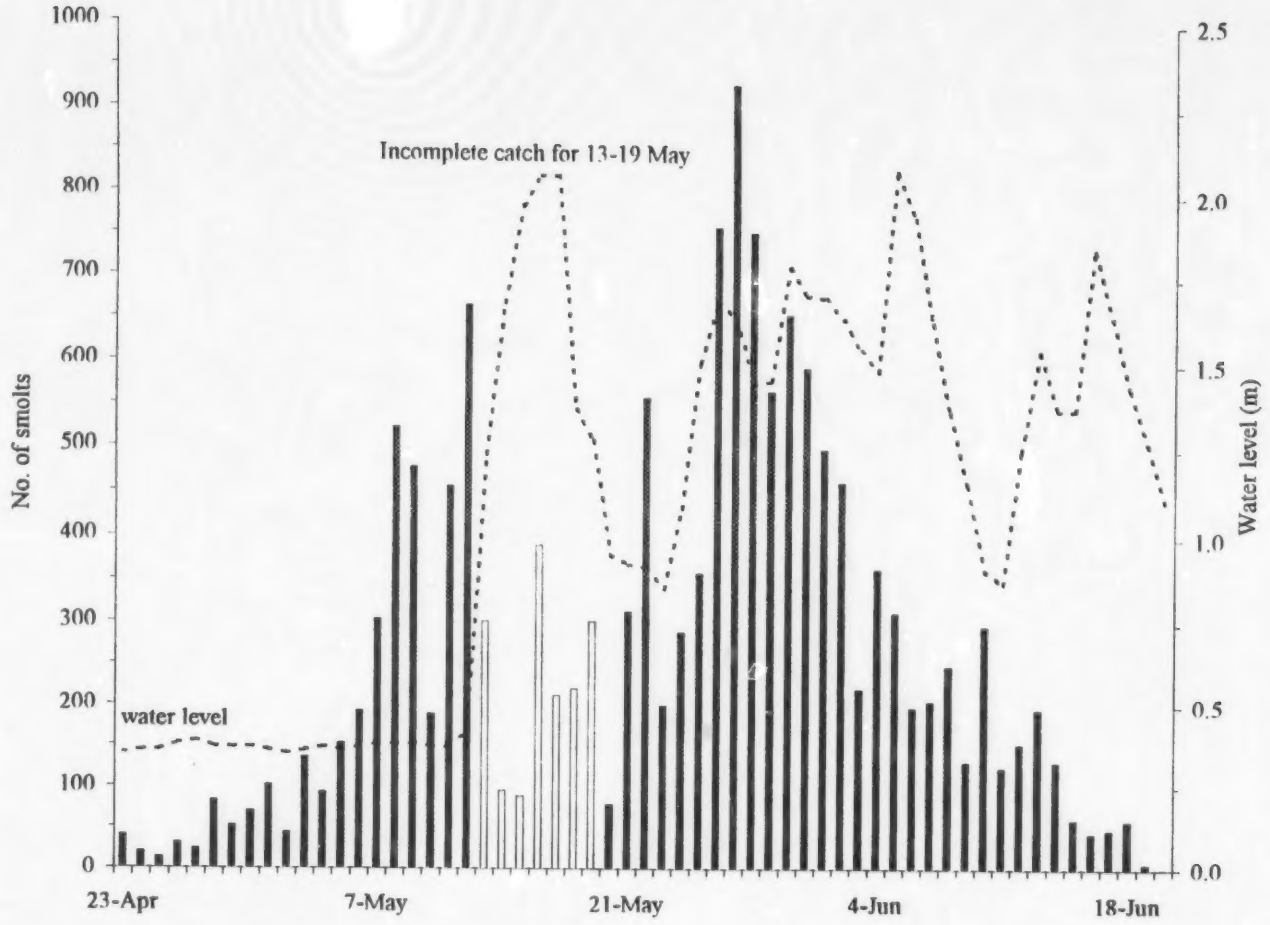

Figure 4. Daily migration of coho smolts at Zolzap Creek, 1997.

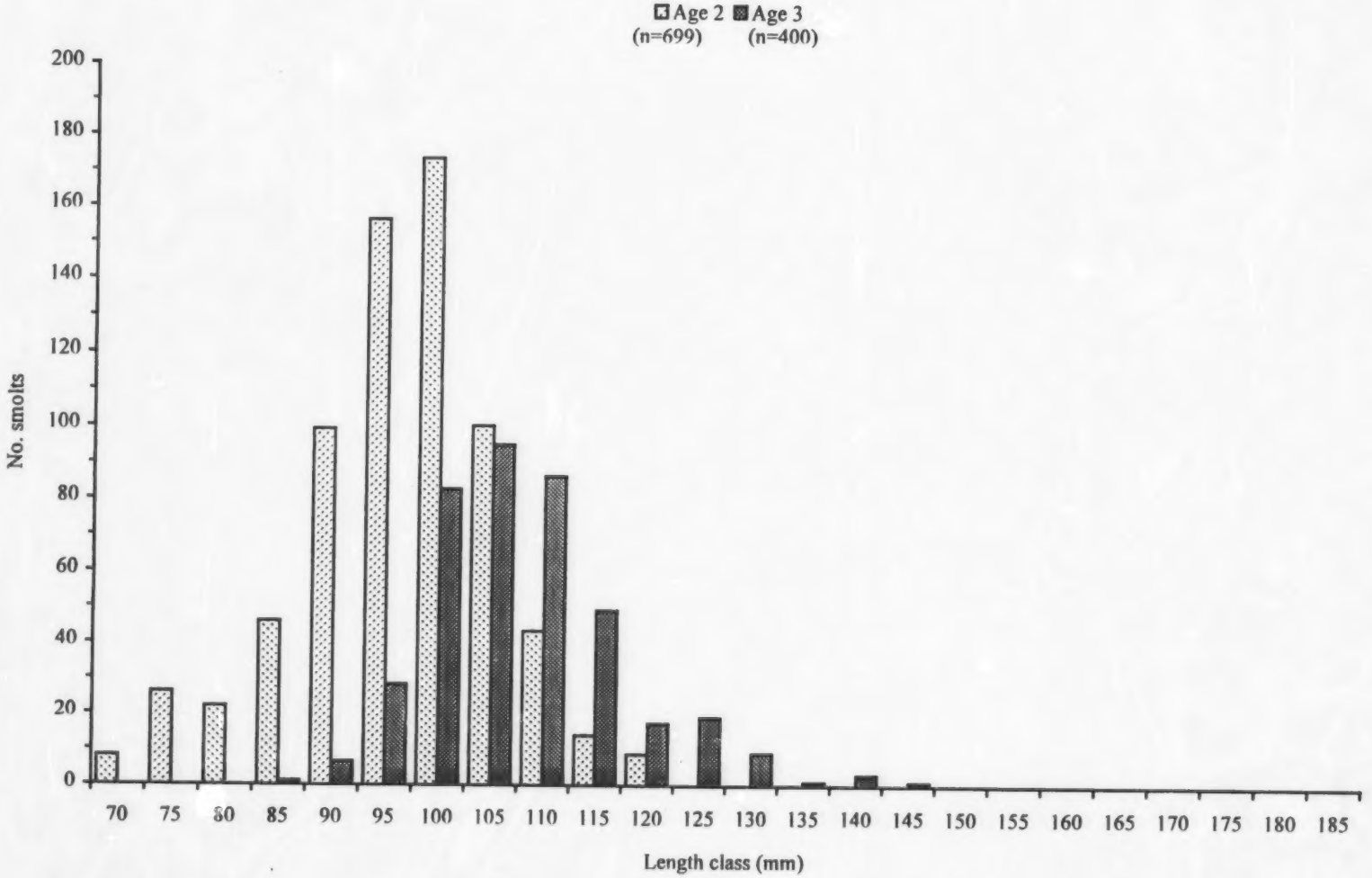

Figure 5. Length-frequency and calculated age distribution of Zolzap Creek coho smolts, 1997.

Figure 6. Daily migration of coho adults at the Zolzap Creek enumeration fence, 1997.

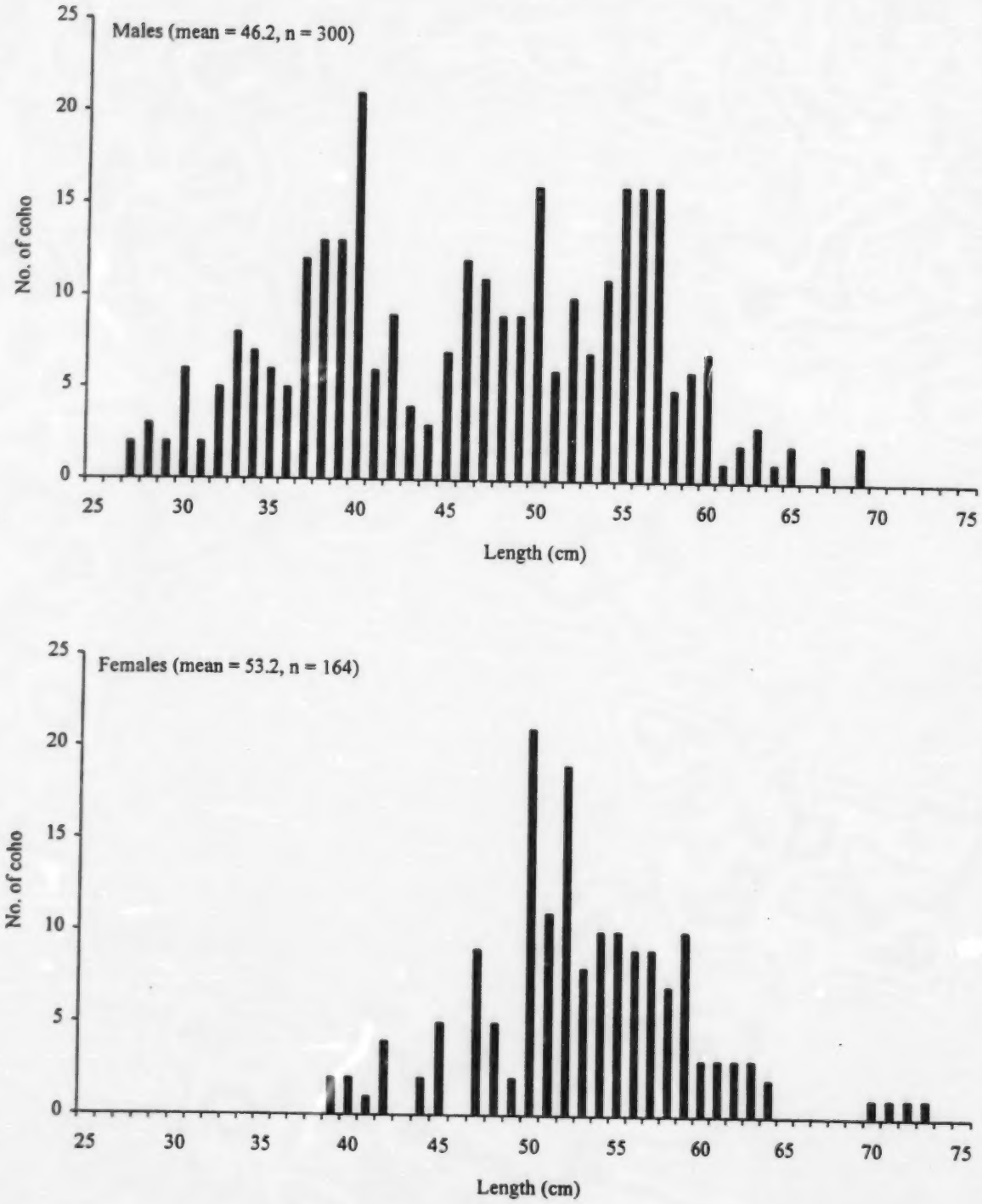

Figure 7. Length-frequency distribution of adult coho, by sex, Zolzap Creek, 1997.

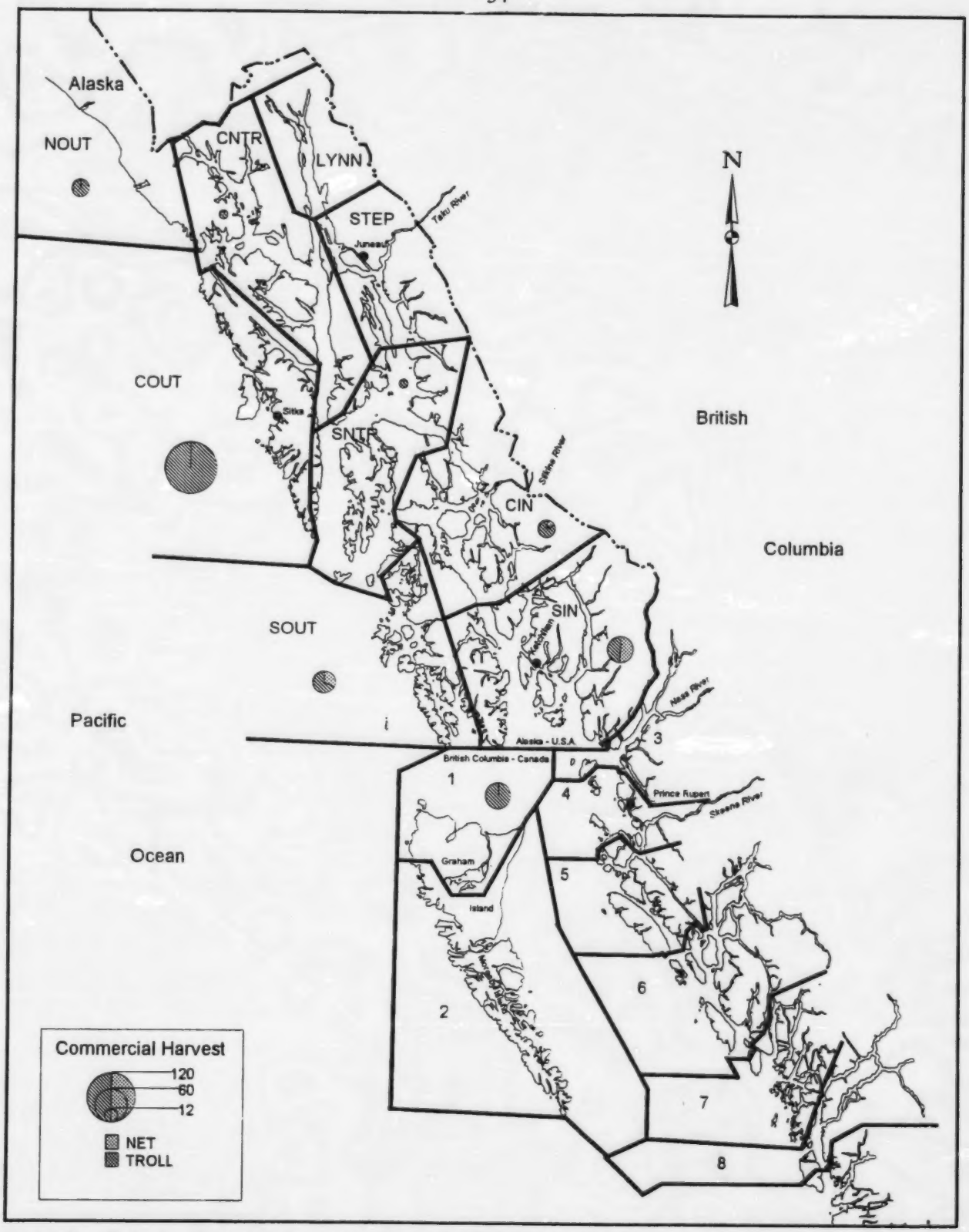

Figure 8. Fisheries Statistical Areas for the north coast of British Columbia and southeast Alaska, and commerical harvest distribution of Zolzap Creek CWT coho, 1997.

APPENDICES

Table A-1. Coded-wire tagging data for coho smolts at Zolzap Creek, 1997.

Date	Total Smolts	Trap Morts	Otolith Mort	No. Escap.	No. rel. Untagged	Tag Code	No. AFC	Hold		Tag Morts	No. rel. AFC
								Juveniles	Smolts		
23-Apr	40	0	0	0	40	0	0	0	0	0	0
24-Apr	20	0	0	0	20	0	0	0	0	0	0
25-Apr	13	0	0	0	13	0	0	0	0	0	0
26-Apr	31	0	0	0	31	0	0	0	0	0	0
27-Apr	24	0	0	0	24	0	0	0	0	0	0
28-Apr	83	1	0	0	82	0	0	0	0	0	0
29-Apr	52	0	5	0	0	0	0	0	47	0	0
30-Apr	70	0	5	0	0	0	0	0	65	0	0
1-May	102	0	5	0	209	0	0	0	0	0	0
2-May	44	0	5	0	39	0	0	0	0	0	0
3-May	136	1	0	0	135	0	0	0	0	0	0
4-May	94	0	0	0	94	0	0	0	0	0	0
5-May	153	0	5	0	148	0	0	0	0	0	0
6-May	193	0	5	0	0	0	0	0	188	0	
7-May	303	0	10	0	0	0	0	0	293	0	0
8-May	523	1	10	0	8	162028	985	0	0	8	977
9-May	478	0	10	0	1	162028	467	0	0	6	461
10-May	189	0	0	0	0	0	0	0	189	0	0
11-May	456	5	10	0	0	0	0	0	441	0	0
12-May	667	2	10	0	5	162028	1280	0	0	5	1275
13-May	301	0	0	0	2	162028	299	0	0	5	294
14-May	96	0	0	0	0	0	0	1	96	0	0
15-May	89	0	10	0	0	0	0	0	79	0	0
16-May	390	0	10	0	0	162028	555	0	0	5	550
17-May	212	0	10	0	0	162028	202	0	0	5	197
18-May	220	0	10	0	0	0	0	0	210	0	0
19-May	301	0	0	1	0	0	0	32	300	0	0
20-May	78	0	10	2	0	162028	576	0	0	7	569
21-May	313	0	10	0	0	162028	303	0	0	4	299
22-May	560	0	10	1	0	0	0	0	549	0	0
23-May	200	0	10	1	0	162028	738	0	0	6	732

Table A-1 (cont.). Coded-wire tagging data for coho smolts at Zolzap Creek, 1997.

Date	Total Smolts	Trap Morts	Otolith Mort	No. Escap.	No. rel. Untagged	Tag Code	No. Tagged	Hold Juveniles	Hold Smolts	Tag Morts	No. rel. Tagged
24-May	289	0	10	0	0	0	0	0	279	0	0
25-May	359	0	10	1	0	162028	627	0	0	5	622
26-May	760	0	10	0	1	162028	749	0	0	6	743
27-May	928	0	10	0	1	162028	917	0	0	7	910
28-May	754	0	10	0	1	162028	743	0	0	4	739
29-May	568	0	10	0	0	162028	558	0	0	5	553
30-May	657	0	10	0	2	162028	645	0	0	4	641
31-May	595	0	10	0	1	162028	584	0	0	11	573
1-Jun	500	0	10	0	0	0	0	0	490	0	0
2-Jun	462	0	10	1	8	162028	933	0	0	5	928
3-Jun	220	2	10	0	0	0	0	0	208	0	0
4-Jun	364	1	10	0	3	162028	558	0	0	3	555
5-Jun	313	0	10	1	0	0	0	0	302	0	0
6-Jun	198	0	10	1	3	162028	486	0	0	6	480
7-Jun	206	0	10	0	0	0	0	0	196	0	0
8-Jun	248	0	0	1	0	0	0	0	247	0	0
9-Jun	131	0	10	0	3	162028	561	0	0	3	558
10-Jun	297	3	10	2	0	0	0	0	282	0	0
11-Jun	124	1	10	2	0	0	0	0	111	0	0
12-Jun	153	4	10	0	7	162028	525	0	0	6	519
13-Jun	196	4	10	0	0	0	0	0	182	0	0
14-Jun	131	0	0	0	0	0	0	0	131	0	0
15-Jun	60	0	0	0	0	0	0	0	60	0	0
16-Jun	43	0	10	0	10	162028	396	0	0	5	391
17-Jun	47	0	10	0	37	0	0	0	0	0	0
18-Jun	58	0	0	0	58	0	0	0	0	0	0
19-Jun	6	0	0	0	6	0	0	0	0	0	0
20-Jun	1	0	0	0	0	0	0	0	0	0	0
Total	15099	25	380	14	992	3564616	13687	33	4945	121	13566

Table B-1. Juvenile coho catch at Zolzap Creek juvenile enumeration fence, 1997.

Date	Fry	Presmolts	Morts
23-Apr	0	0	0
24-Apr	0	0	0
25-Apr	0	0	0
26-Apr	0	0	0
27-Apr	0	0	0
28-Apr	0	0	0
29-Apr	0	0	0
30-Apr	0	0	0
1-May	0	1	0
2-May	0	0	0
3-May	0	0	0
4-May	0	1	0
5-May	0	0	0
6-May	0	0	0
7-May	0	0	1
8-May	0	0	1
9-May	0	0	2
10-May	0	0	2
11-May	0	0	0
12-May	0	2	0
13-May	0	0	0
14-May	27	1	0
15-May	23	0	0
16-May	43	357	0
17-May	69	159	0
18-May	12	42	0
19-May	247	76	3
20-May	389	88	6
21-May	19	33	4
22-May	21	9	0
23-May	28	11	3
24-May	15	16	0
25-May	5	2	0
26-May	7	0	0
27-May	2	1	0
28-May	7	4	0
29-May	6	3	0
30-May	7	0	0
31-May	3	1	0
1-Jun	1	0	0
2-Jun	0	0	0
3-Jun	6	3	2
4-Jun	6	5	1
5-Jun	2	4	1
6-Jun	2	4	0
7-Jun	3	1	1
8-Jun	4	1	0
9-Jun	5	3	0
10-Jun	16	12	3
11-Jun	0	0	0
12-Jun	23	18	4
13-Jun	30	2	0
14-Jun	24	3	0
15-Jun	20	4	0
16-Jun	6	0	0
17-Jun	9	3	3
18-Jun	11	3	0
19-Jun	7	4	0
20-Jun	22	1	0
Total	1,125	874	37

Table C-1. Non-coho catch at Zolzap Creek juvenile enumeration fence, 1997.

Date	Steelhead		Cutthroat		Dolly Varden		Chum	Sockeye			
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	fry	Juvenile	Lamprey	Cottid	Stickleback
23-Apr	0	0	1	0	10	0	1	0	24	18	0
24-Apr	0	0	1	0	1	0	7	0	31	6	1
25-Apr	0	0	1	0	8	0	18	0	20	15	3
26-Apr	0	0	0	0	1	0	11	0	108	13	10
27-Apr	0	0	2	0	19	0	8	0	153	9	4
28-Apr	0	0	1	0	10	3	6	0	326	17	6
29-Apr	0	0	1	0	3	0	11	0	119	2	6
30-Apr	0	0	0	0	8	0	11	0	141	13	3
1-May	0	0	0	0	5	0	1	0	99	4	6
2-May	0	0	0	0	3	0	0	0	24	3	2
3-May	2	0	0	0	6	1	2	0	114	14	3
4-May	0	0	0	0	13	0	1	0	80	9	2
5-May	1	0	0	0	16	0	2	0	74	8	2
6-May	0	0	0	0	4	0	0	0	36	7	2
7-May	0	0	0	0	4	0	2	0	20	4	1
8-May	0	0	1	0	13	0	0	0	95	4	1
9-May	0	0	1	0	12	0	0	0	20	11	2
10-May	0	0	0	0	6	0	0	0	18	1	2
11-May	0	0	0	0	4	0	1	0	22	2	2
12-May	1	0	1	0	33	0	0	0	39	6	3
13-May	0	0	1	0	10	0	0	0	24	6	4
14-May	0	0	0	0	2	0	0	0	74	3	4
15-May	0	0	0	0	4	0	0	0	27	4	0
16-May	0	0	0	0	28	0	0	0	13	27	1
17-May	0	0	0	0	15	0	0	0	16	12	3
18-May	0	0	0	0	13	0	2	0	4	10	3
19-May	0	0	0	0	5	0	1	0	11	15	24
20-May	0	0	8	0	17	0	0	0	18	16	19
21-May	0	0	1	1	2	0	0	0	11	7	2
22-May	0	0	1	0	6	0	0	0	6	4	3
23-May	0	0	3	0	22	1	0	0	6	3	2
24-May	0	0	5	1	5	0	0	0	5	4	1

Table C-1. Non-coho catch at Zolzap Creek juvenile enumeration fence, 1997.

Date	Steelhead		Cutthroat		Dolly Varden		Chum	Sockeye			
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	fry	Juvenile	Lamprey	Cottid	Stickleback
25-May	0	0	0	0	3	0	0	0	3	0	4
26-May	0	0	0	0	0	0	0	0	7	0	1
27-May	0	0	0	0	1	0	2	0	3	2	0
28-May	0	0	0	0	2	0	3	0	3	2	3
29-May	0	0	0	0	0	0	1	0	20	3	2
30-May	0	0	0	0	0	0	0	0	0	0	0
31-May	0	0	2	0	1	0	2	0	5	0	0
1-Jun	0	0	4	0	3	0	5	0	1	0	1
2-Jun	0	0	0	0	0	0	0	0	2	0	0
3-Jun	0	0	0	0	0	0	1	0	1	0	3
4-Jun	0	0	0	0	0	0	2	0	3	0	0
5-Jun	0	0	1	0	0	0	11	0	5	0	1
6-Jun	0	0	0	0	0	0	0	0	3	1	1
7-Jun	0	0	0	0	1	0	4	0	2	0	0
8-Jun	0	0	0	0	1	0	5	0	11	0	0
9-Jun	0	0	0	0	0	0	6	0	6	0	0
10-Jun	0	0	0	0	3	0	10	0	2	0	0
11-Jun	0	0	0	0	1	0	0	0	1	1	1
12-Jun	0	0	3	0	7	0	17	0	19	0	1
13-Jun	0	0	1	0	3	2	33	0	3	0	0
14-Jun	0	0	0	0	0	0	31	0	4	0	0
15-May	0	0	0	0	2	0	33	0	2	1	0
16-Jun	0	0	0	0	0	0	9	0	2	0	0
17-Jun	0	0	0	0	0	0	28	0	1	0	0
18-Jun	0	0	2	0	1	0	39	0	2	0	0
19-Jun	0	0	0	0	0	0	10	0	1	0	0
20-Jun	0	0	0	0	0	0	7	0	1	4	0
Total	4	0	42	2	337	7	344	0	1891	291	145

Table D-1. Daily counts of adult coho at Zolzap Creek enumeration fence, 1997.

Date	No. Examined	No. operculum tagged
2-Sep	0	0
3-Sep	0	0
4-Sep	0	0
5-Sep	0	0
6-Sep	0	0
7-Sep	1	1
8-Sep	0	0
9-Sep	0	0
10-Sep	0	0
11-Sep	0	0
12-Sep	0	0
13-Oct	25	20
14-Oct	25	21
15-Oct	50	45
16-Oct	75	72
17-Oct	159	154
18-Oct	0	0
19-Oct	2	2
20-Oct	0	0
21-Oct	20	19
22-Oct	66	66
23-Oct	9	8
24-Oct	0	0
25-Oct	15	14
26-Oct	12	12
27-Oct	11	11
28-Oct	0	0
29-Oct	0	0
30-Oct	0	0
31-Oct	0	0
1-Nov	0	0
2-Nov	0	0
3-Nov	0	0
4-Nov	0	0
5-Nov	0	0
6-Nov	0	0
7-Nov	0	0
8-Nov	0	0
9-Nov	0	0
10-Nov	0	0
11-Nov	0	0
Total	470	445

Table D-1. Daily counts of adult coho at Zolzap Creek enumeration fence, 1997.

Date	No. Examined	No. operculum tagged
2-Sep	0	0
3-Sep	0	0
4-Sep	0	0
5-Sep	0	0
6-Sep	0	0
7-Sep	1	1
8-Sep	0	0
9-Sep	0	0
10-Sep	0	0
11-Sep	0	0
12-Sep	0	0
13-Oct	25	20
14-Oct	25	21
15-Oct	50	45
16-Oct	75	72
17-Oct	159	154
18-Oct	0	0
19-Oct	2	2
20-Oct	0	0
21-Oct	20	19
22-Oct	66	66
23-Oct	9	8
24-Oct	0	0
25-Oct	15	14
26-Oct	12	12
27-Oct	11	11
28-Oct	0	0
29-Oct	0	0
30-Oct	0	0
31-Oct	0	0
1-Nov	0	0
2-Nov	0	0
3-Nov	0	0
4-Nov	0	0
5-Nov	0	0
6-Nov	0	0
7-Nov	0	0
8-Nov	0	0
9-Nov	0	0
10-Nov	0	0
11-Nov	0	0
Total	470	445